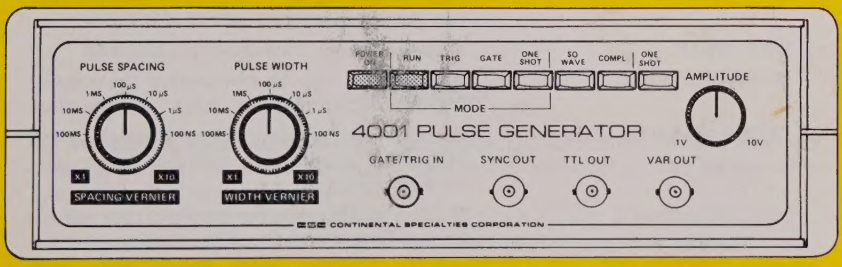
SYL-BB147

4001 ULTRAVARIABLE PULSE GENERATOR



CONGRATULATIONS!

You are part of the growing family of Continental Specialties test equipment owners. You now own a versatile and unique instrument. In order to attain maximum benefit from your 4001 Ultravariable Pulse Generator, please read this manual carefully.

CONTINENTAL SPECIALTIES CORPORATION
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New Haven, Connecticut 06509

4001 SPECIFICATIONS

FREQUENCY RANGE:	0.5 Hz to 5 MHz.
PULSE WIDTH AND SPACING CONTROLS:	100 nsec.-1 sec. in 7 overlapping ranges. Independent variable width and spacing controls. Two concentric, single-turn verniers provide continuous adjustment between ranges.
DUTY CYCLE:	10^7-to-1 range, continuously adjustable.
ACCURACY:	± 5% of control settings calibrated at min. and max. vernier settings.
JITTER:	less than 0.1% + 50 psec.
OPERATING MODES (pushbutton selectable):	
RUN:	0.5 Hz to 5 MHz, frequency settable through pulse width/spacing controls.
TRIG:	DC to approximately 10 MHz from external source.
GATE:	generator starts synchronously with leading edge of gate signal — "One-Shot" pushbutton can manually activate gate in this mode.
ONE SHOT:	enables manual "one-shot" pushbutton.
SQUARE WAVE:	square wave may be obtained at the outputs by depressing "Square Wave" pushbutton.
COMPLEMENT:	outputs may be inverted by depressing the "COMPL" pushbutton, without losing sync time reference. NOTE: pulse spacing controls not active during Trigger and One-Shot modes.
TRIG/GATE INPUT REQUIREMENTS:	TTL compatible input, DC coupled logic input: pulses > 2.4V peak > 40 nsec wide. Sine wave input: > 1.7V RMS < 10 MHz. Input impedance: 400Ω max. input: ± 10V.
OUTPUTS:	
VAR OUT:	amplitude, 0.1-10V, adjustable via single turn vernier; rise/fall time 30 nsec; impedance, 50Ω.
TTL OUT:	fan out, 40 TTL loads; sink, 64 mA at 0.8V maximum; rise/fall time: less than 20 nsec.
SYNC OUT:	amplitude 2.4V minimum; fan out, 10 TTL loads; sink, 16 mA at 0.8V maximum; rise/fall time, less than 20 nsec; sync pulse lead time, greater than 20 nsec.
POWER REQUIREMENTS:	105-125 50/60 Hz, 6 watts; 220-240 VAC, 50/60 Hz optional.
OPERATING TEMPERATURE:	0°C to 50°C (calibrated at 25°C±5°C).
SIZE (WxHxD):	10" x 3" x 7" (254x76x178mm).
WEIGHT:	2.2 lbs. (1 kg).

TABLE OF CONTENTS

	PAGE
SPECIFICATIONS	2
INTRODUCTION	3
FRONT PANEL CONTROLS: LOCATIONS AND DESCRIPTIONS	4
APPLICATIONS	6
CHECKING OUT THE 4001	13
CIRCUIT DESCRIPTION	17
SCHEMATIC	19
WARRANTY AND FACTORY SERVICE NOTES	20

Introduction

The 4001 is a compact, flexible, wide range DC to 5 MHz, reliable low cost Pulse Generator. Its uncomplicated rugged design and high quality components ensure long and dependable service.

The 4001, primarily designed as a pulse or clock source, is compatible with IC and discrete component circuits. It also finds application as a system stepper (One-Shot Mode); gated oscillator (Gate Mode); or pulse stretcher (Trigger Mode). With a minimum of adjustments; the 4001 can also serve as a missing pulse detector or a frequency discriminator. The output can be complemented or converted to a square wave with a push of a button.

Features such as two Simultaneous Independent Outputs (TTL and Variable) with rise and fall times less than 30 nsec; 20 nsec TTL compatible leading-edge Sync pulse output; independent pulse width and pulse spacing controls (both selectable from 100 nsec to 1 sec) eliminating incompatible frequency and pulse width settings; four front panel pushbutton selectable operating modes (Run, Trigger, Gate, and One-Shot); and an uncomplicated front panel layout, all add up to an effective solution to a wide range of pulse source problems.

PANEL CONTROLS AND TERMINALS

Refer to Fig. 1 for location of all front panel features (These numbers will be referred to throughout the entire text).

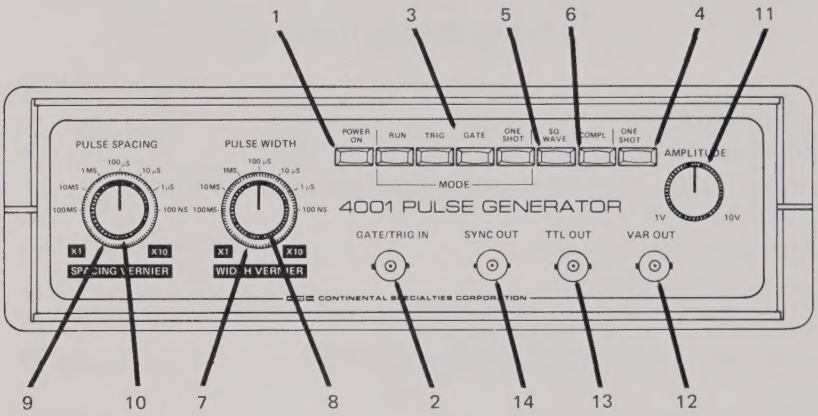


FIGURE 1

PUSH BUTTONS:

Power Switch: (1)

When the push button is depressed, the 4001 is turned on.

Gate/Trig Input: (2)

The gate/trig. input terminals are DC coupled to the 4001 internal circuitry. The input signal can be a sine wave greater than 1.7RMS or a positive pulse greater than 2.4V Amplitude must not exceed ± 10V.

Mode Switches: (3)

NOTE: The Mode Switches are mechanically interlocked, allowing only one switch to be activated at a time.

Run: In the Run mode, the 4001 is self-oscillating. All external inputs are disconnected, and all timing controls are functional. (Fig. 2)

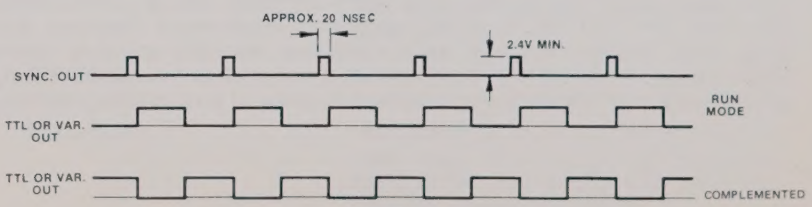


FIGURE 2

Trig: In the Trig mode, the 4001 outputs produce a synchronous positive-going output pulse for each positive input trigger. The output pulse width is adjusted by the Pulse Width and Width Vernier controls. The output pulse is initiated by the positive-edge of the input trigger. When the mode switch is in the trigger mode, the Pulse spacing and Spacing Vernier controls are inactive (Fig. 3).

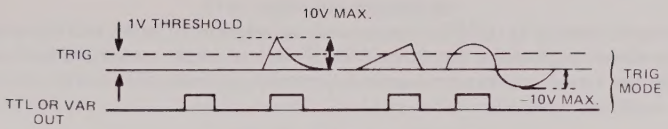


FIGURE 3

Gate: In the Gate mode, the 4001 outputs produce trains of pulses for the duration of the applied gating signal. The leading edge of the gating signal starts the output pulse train. The first pulse in the train is synchronized with the lead edge of the gating signal. Both the Pulse Spacing and Pulse Width controls program the pulse train parameters. If the gating pulse ends while an output is present, the last pulse will be completed (Fig. 4).

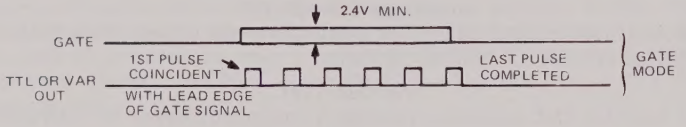


FIGURE 4

One-Shot: (4)

In the One-Shot mode push button #4 initiates an output pulse: The output pulse occurs as the push button is depressed. Pulse parameters are set by the Pulse Width and Width Vernier controls. Pulse spacing and Spacing Vernier controls are not active (Fig. 5).

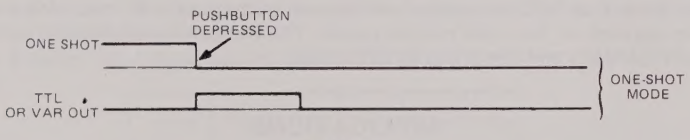


FIGURE 5

Square Wave: (5)

When this button is depressed the output is converted to a square wave. The output now changes state with every positive edge of the original "Programmed" waveform. This divides the frequency of the signal by 2. All inputs and controls are still functional (Fig. 6).

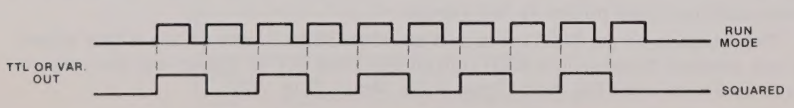


FIGURE 6

Complement: (6)

When this button is depressed the TTL and Var. outputs are automatically complemented (Fig. 2). All inputs and controls are still functional.

Pulse Width Switch: (7)

The Pulse Width Switch is used to select output pulse widths from 100nsec to 1 sec in 7 ranges. When used in conjunction with the Width Vernier continuous adjustment over the entire instrument range is achieved.

Width Vernier: (8)

The Width Vernier is used for continuous adjustment of pulse width between the limits of the range set on the Pulse Wide Switch. A slight overlap at both ends of the Vernier range insures continuous adjustment over the entire seven decades of pulse width adjustment.

Pulse Spacing Switch: (9)

The Pulse Width Switch is used to select output pulse spacing from 100 nsec to 1 sec in 7 ranges. When used in conjunction with the Spacing Vernier, continuous adjustment cver the entire instrument range is achieved.

Spacing Vernier: (10)

The Space Vernier is used for continuous adjustment of pulse spacing between the limits of the range set on the pulse spacing switch. A slight overlap at both ends of the vernier range insures continuous adjustment over the entire seven decades of pulse spacing adjustment.

Amplitude Control: (11)

The Amplitude control adjusts the amplitude of the voltage at the VAR OUT BNC connector from 0.1 Volts to 10 Volts.

Var Out: (12)

The Var Out BNC connector provides a convenient means for interconnecting the generator output to its destination. The VAR OUT signal has a rise and fall time of 30 nsec and output impedance of 60 ohms.

TTL Out: (13)

The TTL Output BNC connector is fed by four TTL gates in parallel, providing a TTL fanout of 40. Rise and fall times are less than 20 nsec Both TTL and VAR OUT pulses are derived from the same internal source and are synchronous.

Sync Out: (14)

The Sync Out BNC connector produces an output pulse 20 nsec wide and 20 nsec in advance of the main output pulses. The Sync pulse amplitude is a minimum of 2.4 Volts and can drive 10 TTL loads.

APPLICATIONS

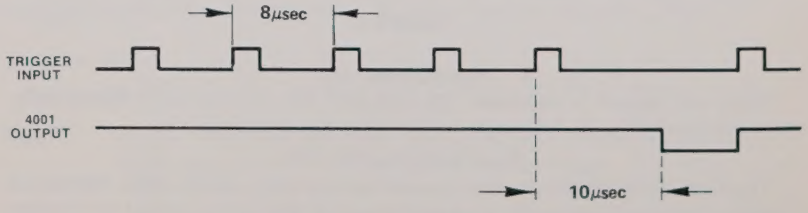
The 4001 Pulse Generator with its many features and ease of operation make it a welcome addition to any lab.

The following is just a sampling of the varied uses the 4001 offers.

Missing-Pulse Detector

Program the 4001 pulse width for 10μsec. Set the input trigger pulse repetition period (PRP) to 8μsec. Each time the trigger pulse goes positive, the 4001 is reset and must time out to its full 10μsec.

The outputs of the 4001 remain in the High State. If one of the trigger pulses is not present (missing) the 4001 output will time out to 10μsec and then return to its low state until the next trigger pulse occurs (Fig. 7).



USE AS A MISSING PULSE DETECTOR

FIGURE 7

Tracing Digital Logic Flow

The 4001 and a digital logic probe such as CSC's LP-3 make a superior troubleshooting team. Just use the 4001 as a signal injector to inject either a pulse train, a single one-shot, or the complement of either. Then trace through the circuits with your LP-3 and quickly find the defective component.

Analysing a Microprocessor Program

By substituting your 4001 for the microprocessor system clock you can give your microprocessor the capability of stepping through its microprogram either a step at a time (in One-Shot mode) or at much reduced speed, by using long timing periods in "Run" mode.

Note, however, that some microprocessors have a minimum clock speed, below which correct operation is not assured. If in doubt, check the data sheet for the microprocessor that you are using.

Testing Radio Control Receivers

Proportional radio control is usually implemented by sending a variable mark-space ratio low frequency modulation on a radio-frequency signal. Your 4001 may be used to simulate the radio transmitter when testing the low-frequency stages of your receiver. The 4001 is also ideal for simulating the joystick input to the transmitter.

Audio Testing

The 4001 again shows its versatility in testing audio amplifiers. Square waves are used in audio testing to display a wide range of frequencies simultaneously. Square waves consist of a fundamental frequency, and a series of odd harmonics to square off the wave shape.

For an amplifier to reproduce a square wave it must have a flat frequency response from 0.1F to 10F where F is the fundamental frequency of the square wave.

The traditional test frequencies are 50 Hz for the low. frequency test and 10kHz for the high frequency end.

Fig. 8 shows the typical square wave patterns and an interpretation of these shapes.

Waveform	LF Gain	LF Delay	HF Gain	HF Delay	Damping
	OK	OK	OK	OK	OK
	L	OK	H	OK	H
	H	OK	L	OK	H
	OK	H	OK	L	H
	OK	L	OK	H	H
	H	H	L	L	H
	H	L	L	H	H
	L	H	H	L	H
	OK	OK	H	OK	OK
	OK	OK	H	OK	L
	OK	OK	H	OK	LL
	OK	OK	*	OK	L

*Sharp Cutoff or Peaked

L = Low
LL = Very Low
H = High

FIGURE 8

Connect the 4001 to the amplifier under test as shown in Fig. 9 and observe output on the scope. Fig. 10 shows a convenient table of power and voltage relationships for 4Ω and 8Ω speakers. It also lists the output voltage level for 10dB below the maximum output of amplifiers with different power ratings. Choose the rating closest to the amplifier under test. Testing at 10dB below maximum output ensures that the amplifier will not be in saturation. This level is approximately 2/3 of the full power output.

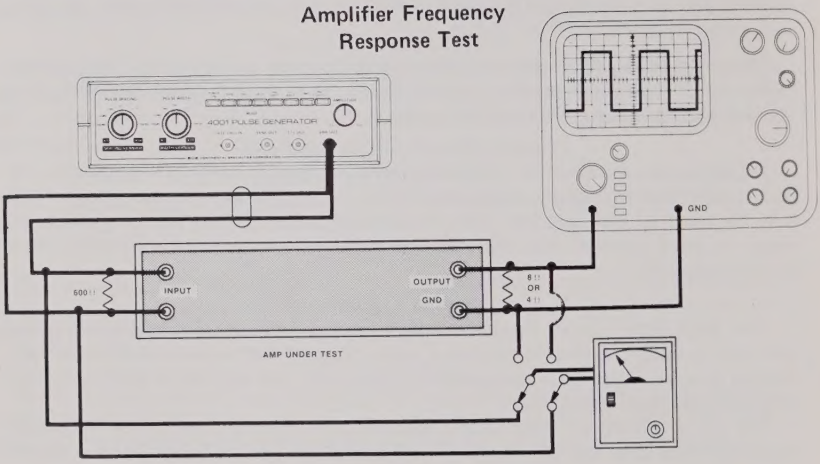


FIGURE 9

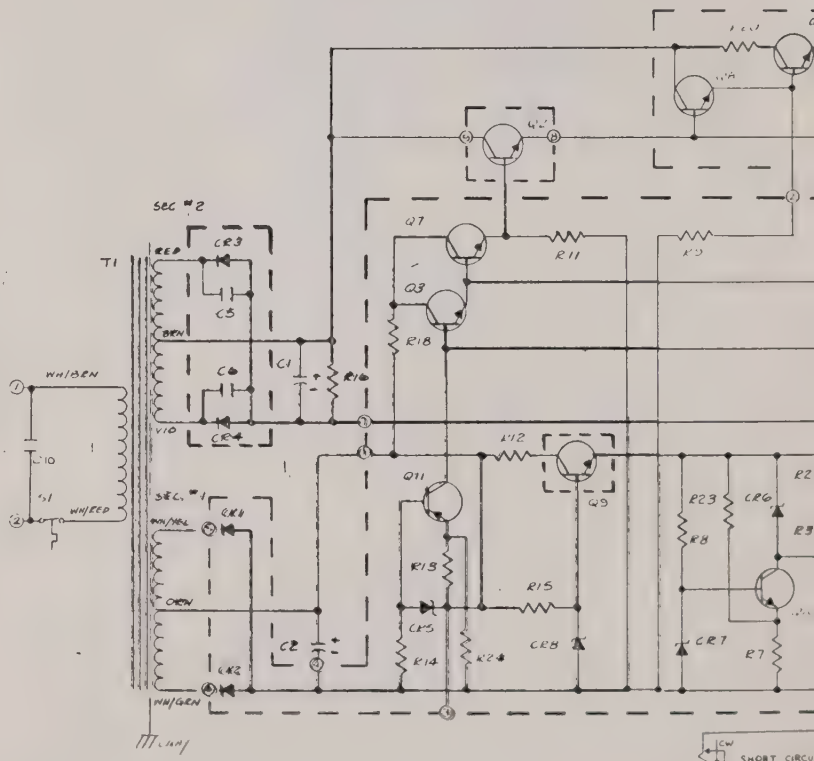
Power/Output Relationships

POWER RATINGS (RMS)			OUTPUT (RMS)	
8 Ω	4 Ω	E^2	FULL OUTPUT	10 dB BELOW MAX. OUTPUT
1W	.5W	8V	2.8V	2.3V
5W	2.5W	40V	6.3V	5.2V
10W	5.0W	80V	8.9V	7.3V
20W	10.0W	160V	12.6V	10.3V
50W	25.0W	400V	20.0V	16.3V
100W	50.0W	800V	28.0V	23.1V

FIGURE 10

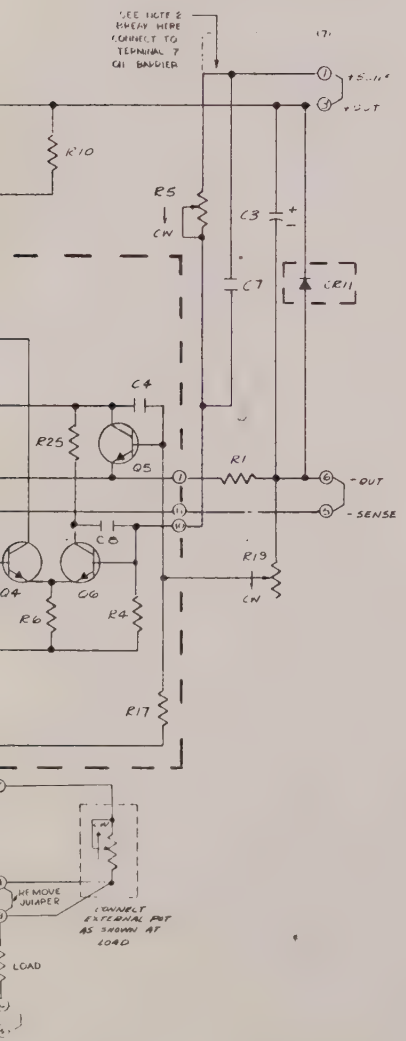
-RS.

R1-500 ohm E900 SSAB
R2- 3K 5% 1/2W
R3- 91 ohm 5% 1/2W
R4- 470 ohm 5% 1/2W
CR1- IN457
CR2- P4280
SCR1- MCR1305-1 MOT
SCS1-3N81
F1- 5AMP 3AG 312000 QK.ACT
R8- 5.1K ohm 5% 1/2W
C2- .22 MF 200V
SCHEMATIC- P5840



NOTE: 1- R5 & R13, ARROWS INDICATE CLOCKWISE DIRECTION FOR INCREASE IN VOLTAGE/CURRENT.
2- MODIFY AS SHOWN WHEN REMOTE VOLTAGE ADJUST IS SPECIFIED.

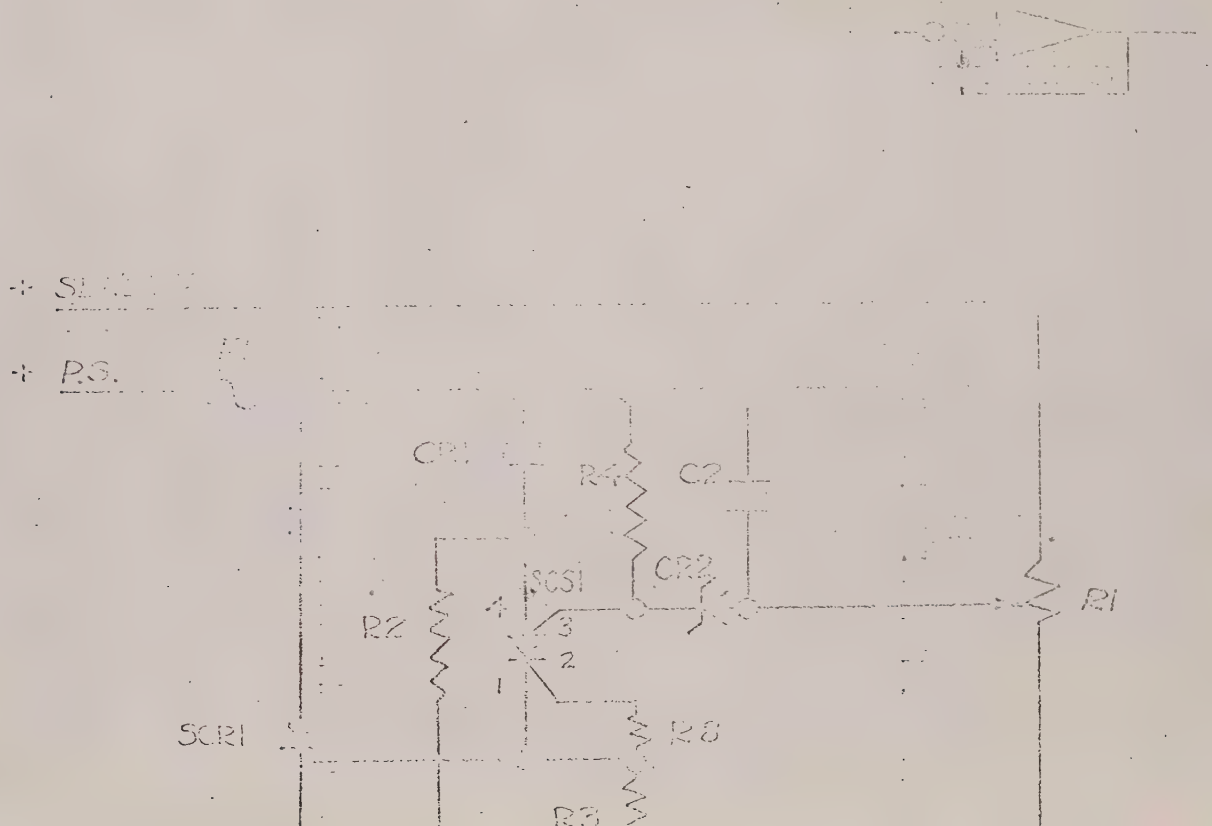
CON AVIONICS



C 1	P5453 (4) (2300 mfd 20V)
C 2	P5050 (120 mfd 75V)
C 3	P5661 (800 mfd 10V)
C 4	CK62BX332K
C 5	.22 mfd 200V
C 6	.22 mfd 200V
C 7	TFD-11X550-153K-DD
C 8	CK62BX222K
C 10	.22 mfd 200V
CR 1	HC69
CR 2	HC69
CR 3	368A
CR 4	368A
CR 5	P4281
CR 6	P4281
CR 7	P4281
CR 8	P5457
CR 10	HC68
Q 1	P4716
Q 2	P3923
Q 3	P3923
Q 4	P5152
Q 5	P5152
Q 6	P5152
Q 7	P3923
Q 8	P4717
Q 9	P5148
Q 10	P5152
Q 11	P4931
R 1	.30hm 5% 10 W
R 2	43 ohm 5% 1/2 W
R 3	1K 3% 3W
R 4	510 ohm 3% 3 W
R 5	Pot 750 ohm 2 W
R 6	1.3K 5% 1/2 W
R 7	150 ohm 5% 1/2 W
R 8	470 ohm 5% 1 W
R 9	1.1K 5% 2 W
R 10	220 ohm 5% 1/2 W
R 11	12K 5% 1/2 W
R 12	130 ohm 5% 2 W
R 14	3K 5% 2 W
R 15	12K 5% 3 W
R 16	1.8K 5% 1 W
R 19	Pot 500 ohm 1.5 W
R 20	.6 ohm 5% 25 W
R 23	Select in Test
R 24	470 5% 1/2 W
R 25	1K 5% 1/2 W
S 1	P4781
T 1	P5611

MODEL HT 5-4.0A
RATING 0-5.5V-4.0A

CON AVIONICS CORP
HT 5-4.0A
46W
D

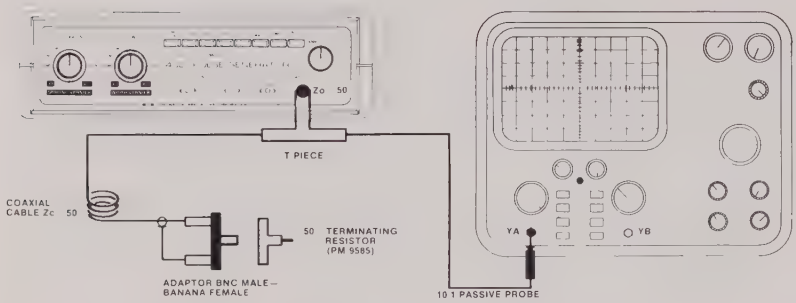

+ SL
+ P.S.
CR1
R4
C2
CR2
SCS1
R2
R1
SCR1
R3

Testing Transmission Lines

If a transmission line is not terminated at the far end by its characteristic impedance, reflections will occur. This phenomenon can be used to find faults on transmission lines. Using your 4001 you can find out if the cable under test is open, or short circuited, and with some simple calculations, you can find the length of the cable.

Equipment

1 – 4001 pulse generator
1 – 50Ω coaxial cable to be tested (≅10m long)
1 – oscilloscope
1 – passive probe 10:1
1 – 50Ω termination
1 – adaptor banana female – BNC male
1 – BNC T – connector



Transmission Line Test

FIGURE 11

Set up the equipment as shown in Fig. 11

Set the 4001 to:
Amplitude – 6.5V
Pulse width time – 5μsec
Pulse space time – 5μsec
Square Wave – engaged
(use VAR. output connector)

Set the scope to:
Vertical Display – 1V/cm
Input Coupling – DC
Trig Source – Int
Trig Mode – Auto
Trig Level – Adjusted
Sweep time – 2μsec/cm

With the far end open, the scope should display a signal as shown in Fig. 12a. The final amplitude is reached in two steps. At the moment the 4001 meets the 50Ω of the cable itself, the output is at nominal value (midscale dots B on Fig. 12a) and a reflection takes place at the open end. When this reflection feeds back to the pulse generator output, it tells the 4001 that the far end is open, and the open circuit voltage of the 4001 appears.

Now change the Time/Div of the scope to 0.1μsec and observe the signal in Fig. 12b. The time between points A and B is the time that it takes for the missing signal to reach the open end and return. For example, assume that (as in Fig. 12b) the reflection takes 120nsec. It is known that the velocity of a signal in a coaxial cable is about 0.7C (C = 3×10^8 m/sec). If the cable has the length L it will take 2 L/0.7C before the signal returns as a reflection. Using the time observed on the scope the cable length is calculated as shown:

$$T = \frac{2L}{0.7C} \text{ where T is Time for return Reflection}$$

Solving for L we get:

$$L = \frac{0.7CT}{2}$$

$$L = \frac{(0.7) \times (3 \times 10^8 \text{ m/sec}) \times (120 \times 10^{-9} \text{ sec})}{2}$$

$$L = 12.6 \text{ meters}$$

Remember that the accuracy of this result is determined by the Time-Base accuracy.

Short circuiting the end of the cable results in the waveform shown in Figs. 12c, d. After 120nsec the 4001 "knows" that its output is short circuited and the voltage drops to Zero. The cable load influences this ideal behavior and Zero means "almost" Zero, which can be noticed from the offset level with respect to the start.

Terminating the far end with 50Ω results in the waveform shown in Fig. 12e.

Matching the far end of the cable with a resistor equal to the characteristic impedance completely eliminates reflections from the far end, resulting in a perfect square wave at the generator end of the cable.

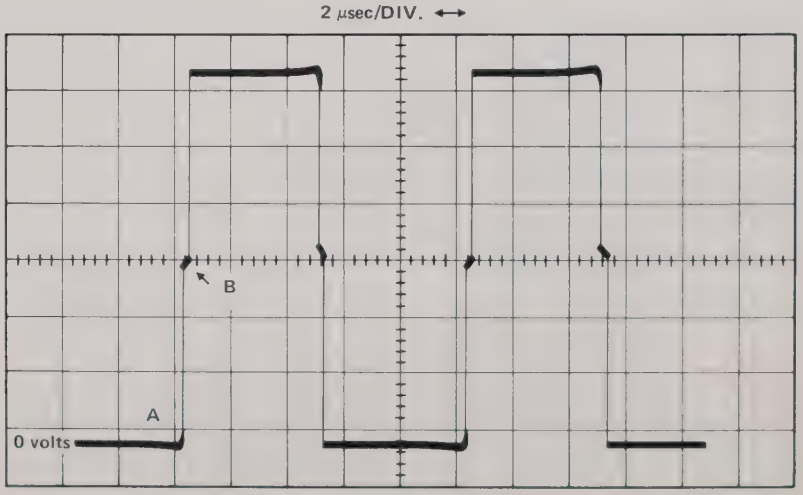


FIGURE 12a

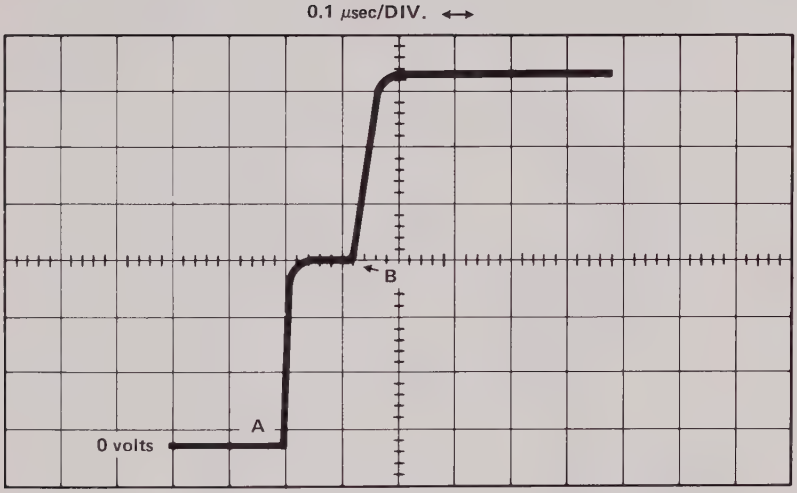


FIGURE 12b

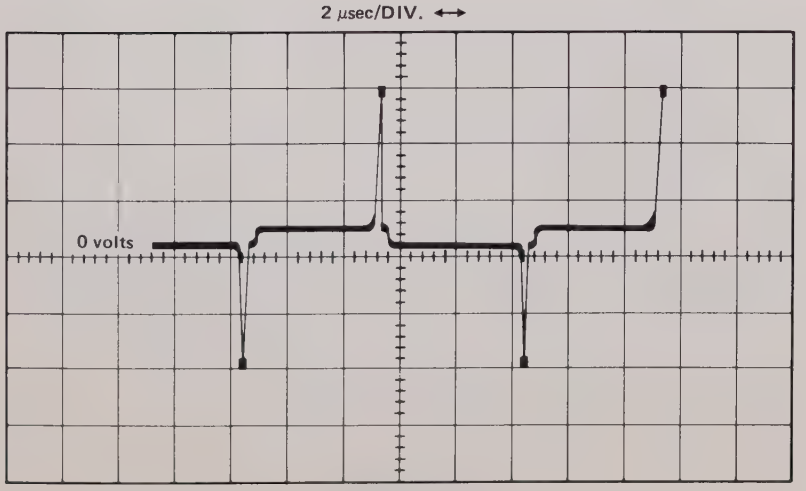


FIGURE 12c

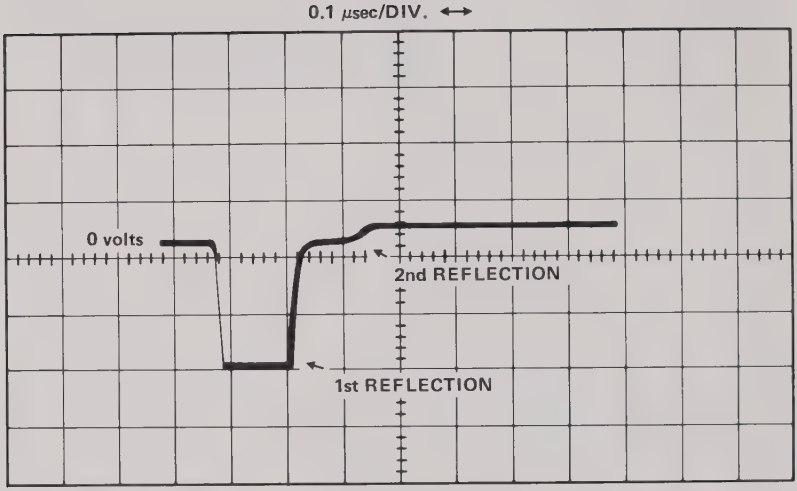


FIGURE 12d

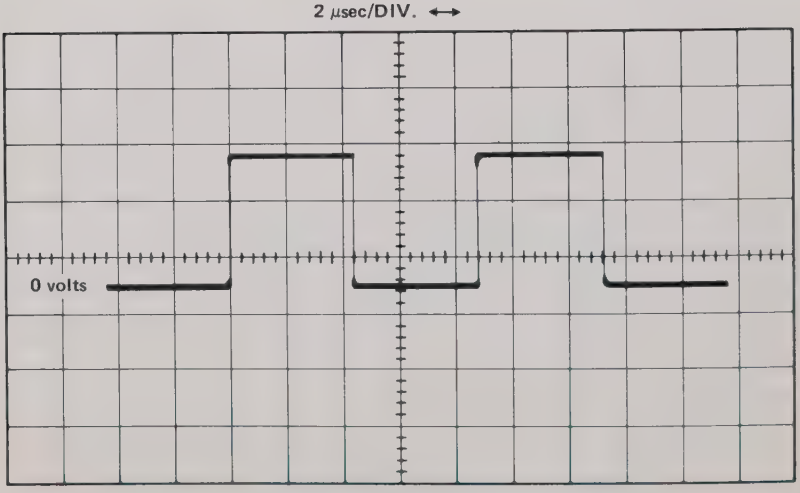


FIGURE 12e

Checking Out the 4001

The 4001 is a versatile instrument, designed for simplicity and ease of operation. In order to verify proper operation, the following checkout procedures should be followed. A Tektronix 475 oscilloscope, or equivalent, will be needed with a 10-to-1 probe with a shunt capacity of 15pF or less.

RUN MODE:

Step A: Set the following controls on the 4001 under test to the positions specified.

CONTROL	POSITION
Power (1)	ON
Mode (3)	RUN
Pulse Width SW (7)	10 μsec to 1 μsec
Pulse Spacing SW (9)	10 μsec to 1 μsec
Width Vernier (8)	Mid-range
Spacing Vernier (10)	Mid-range
Amplitude (11)	10V

Step B: Set the following controls on your scope to the positions indicated:

CONTROL	POSITION
Sweep Time	1 μsec/cm
Vertical Display	2 volts/cm DC input
Trigger Mode	External DC
Trigger Polarity	Positive

Step C: Connect the scope probe to the VAR OUT Connector on 4001;

Step D: Connect the sync. output terminal on the 4001 to the trigger input on the scope. (Fig. 13)

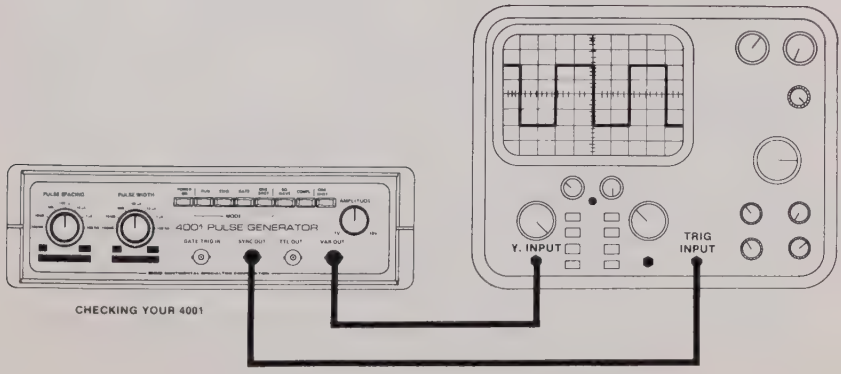


FIGURE 13

NOTE: A 10 μsec SQUARE WAVE WILL BE VISIBLE ON THE SCOPE. TRIM UP BOTH THE WIDTH AND SPACING VERNIERS FOR EXACTLY 5 μsec WIDTH AND SPACE TIMING.

Step E: Turn the Width Vernier from mid-range counterclockwise toward "X1" and observe the pulse width shrinking down to 1μsec. Since the pulse spacing time has remained the same, the pulse repetition period (PRP) is now the sum of the 1μsec pulse width and the 5μsec pulse spacing, or 6μsec.

Step F: Turn the Spacing Vernier clockwise towards "X10", and observe the increase in pulse spacing. The PRP will increase to 10 μsec the pulse width remains 1μsec and the duty cycle decreases from 50% for a square wave to 10%.

Complement: Quite often in digital work a narrow pulse is required that has a long PRP, as long as 1 second. This can be achieved with the 4001 by simply setting the Pulse Spacing switch to the 1 sec to 100 msec range. The complement of the above pulse train can be realized by simply pushing the Complement button. If the width was set as 1μsec and spacing at 1 sec, the complement will have a width of 1 sec and spacing of 1μsec after the Complement button is depressed. (Fig. 14)

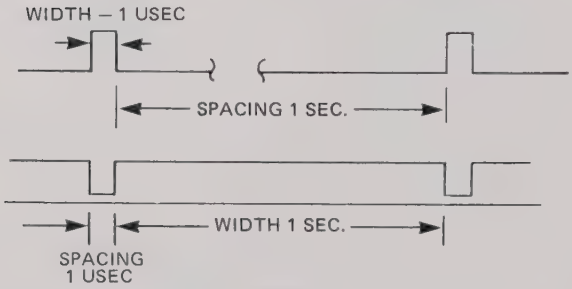


FIGURE 14

TRIGGER MODE:

Step A: Set the following controls on the 4001 to the positions specified:

CONTROL	POSITION
Mode (3)	Trig
Pulse Width SW (7)	1 msec — 10msec
Width Vernier (8)	X1

(Pulse Spacing controls are inactive in the trigger mode).

Step B: Set the controls on the Pulse Generator (trigger pulse source) for the following output conditions:

CONTROL	POSITION
Pulse Width	100μsec
Pulse Spacing	10msec
Pulse Polarity	positive
Pulse Amplitude	2V
Mode	Run

Step C: Connect the Pulse Generator (trigger pulse source) output terminals to the 4001 gate/trig terminals. (Fig. 15)

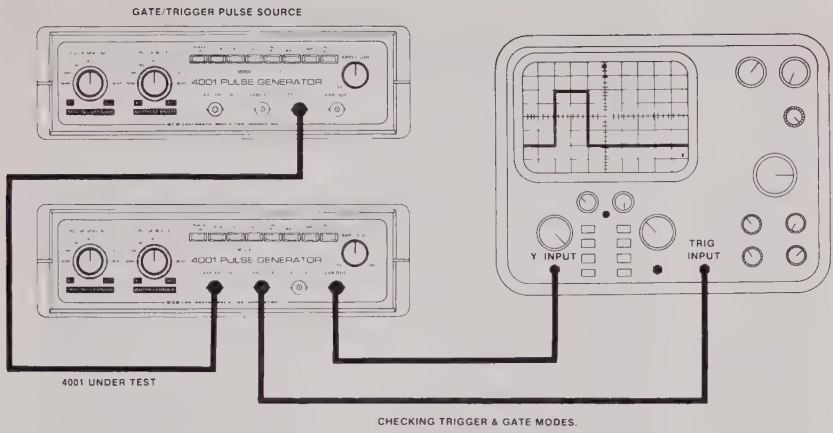


FIGURE 15

Step D: Set the following controls on your scope to the positions indicated:

CONTROL	POSITION
Sweep time	1msec/cm
Vertical Display	2V/cm DC input
Trigger mode	External DC
Trigger Polarity	Positive

Step E: Connect the scope probe to the VAR OUT terminals on the 4001.

Step F: Connect the sync output on the 4001 to the trigger input terminal on the scope.

NOTE: YOU SHOULD NOW SEE A 1msec PULSE ON THE SCOPE.

Step G: Decrease the pulse spacing time on the Pulse Generator (trigger source) to 5msec, and observe that the pulse spacing on the scope decreases as the 4001 PRP tracks the PRP of the trigger source. The 4001 pulse will remain 1msec wide.

Step H: Slowly decrease the pulse spacing time on the pulse generator (trigger source) to below 1msec. At the point where the PRP of the trigger input is less than the 4001 pulse width, the 4001 output goes high and remains high.

By using the above retriggerable characteristics of the 4001, the instrument can be used as a frequency discriminator, or missing pulse detector.

GATE MODE:

Step A: Set the following controls on the 4001 to the positions specified:

CONTROL	POSITION
Mode (3)	Gate
Pulse Width SW (7)	1μsec – 100nsec
Width Vernier (8)	Mid-range
Pulse Spacing SW (9)	1μsec – 100nsec
Spacing Vernier (10)	Mid-range
Amplitude Control (11)	10V

Step B: Set the controls on the pulse generator (gate pulse source) for the following output conditions:

CONTROL	POSITION
Pulse Width	5μsec
Pulse Spacing	5μsec
Pulse Polarity	positive
Pulse Amplitude	2V
Mode	Run

Step C: Connect the pulse generator (gate pulse source) output terminal to the 4001 gate/trig terminals.

Step D: Set the following controls on your scope to the positions indicated:

CONTROL	POSITION
Sweep Time	1μsec/cm
Vertical Display	2V/cm DC input
Trigger Mode	External DC
Trigger Polarity	Positive

Step E: Connect the scope to the VAR OUT connector on the 4001.

Step F: Connect the sync output on the 4001 to the trigger input terminals on the scope (Fig. 15).

NOTE: YOU SHOULD NOW SEE A PULSE TRAIN CONSISTING OF FIVE 0.5 μSEC PULSES SPACED 0.5 μSEC APART.

Step G: Gradually decrease the pulse width control on the pulse generator (gate source) from 5μsec to 1μsec. As the gate pulse decreases, the last pulse on the pulse train will disappear. When the gate source pulse width is below 1μsec, only one pulse will be left in the original pulse train.

Step H: Disconnect the pulse generator (gate source) from the trig/gate terminals on the 4001.

Step I: Depress the One-Shot pushbutton, and observe the train of 1μsec square waves appearing on the scope. The One-Shot pushbutton can manually gate the 4001. This allows the 4001 to act as a tone-burst generator or manual pulse train generator.

ONE SHOT MODE:

Step A: Set the following controls on the 4001 to the positions specified:

CONTROL	POSITION
Mode (3)	One Shot
Pulse Width SW (7)	10msec — 1msec
Width Vernier (8)	X10
Amplitude Control (11)	10V

(Pulse spacing controls are inoperative in this position).

Step B: Set the following controls on the scope to the positions indicated:

CONTROL	POSITION
Sweep Time	5msec/cm
Vertical Display	2V/cm
Trigger Mode	External DC
Trigger Polarity	Positive

Step C: Observe the scope while depressing the One-Shot pushbutton. When the pushbutton is depressed, a 10msec pulse will appear on the scope. It will appear only when the button is depressed. No pulse will occur when the pushbutton is released.

CIRCUIT DESCRIPTION

Fig. 16 shows the schematic diagram of the 4001 Pulse Generator. The heart of the pulse generator is the integrated circuit A-1 dual monostable multi-vibrator #74123. The two monostable multi-vibrators are cross-coupled from the $\bar{Q}$ output of the first to the A input of the second and vice-versa.

Anti-Latch Circuit Operation

The cross coupled monostable multi-vibrator circuits oscillate as long as their "B" inputs are high. However, since the coupling between the two circuits is purely DC it is possible for the oscillator to latch-up. The problem is overcome by a special triggering circuit that is gated on if A-1 fails to oscillate. Transistors Q-1 and Q-2 form a hook oscillator. R-14 and R-15 bias the base of Q-1 to ½Vcc while the emitter of Q-1 is controlled by R-11 and R-12. These resistors are connected to the $\bar{Q}$ output of the A1-A and A1-B. As long as A-1 oscillates, one of the $\bar{Q}$ outputs will be high. The average voltage at the emitter of Q-1 will be half the $\bar{Q}$ high voltage. This holds the emitter of Q-1 more negative than its base, and Q-1 is cut off.

If the oscillator stops, both $\bar{Q}$s go high. Q-1's emitter voltage rises above its base voltage and starts to conduct. Q-1 and Q-2 turn on and latch, discharging C-15. As Q-1 and Q-2 recover from the latch condition, the B input of A1-A goes high, forcing Q of A1-A low, turning off the hook circuit and restarting the oscillator.

Timing Circuit Operation

The timing of A1-A is controlled by the selection of capacitors C-1 through C-7 and the resistors R-1 through R-5.

The timing resistor R-2 and R-3 and the trim pots R-1 and R-4 set the range for R-5, the Spacing Vernier. A1-B timing system is the same as A1-A.

Mode Switch Operation:

Run Position: In the run mode, S1 removes the 5 volts from the input to A7-B causing the output to go high, enabling the oscillator.

Trig. Position: In the trig. position, S-1 applies 5 volts to R-13, Q-2 saturates and shorts the B input of A1-A to ground, disabling A1-A. When a positive trigger pulse appears at J-1, Q-3 emitter goes high and A7-A low, A7-B goes high, triggering A1-B on.

Gate Position: In the gate position, S-1 ties both the base of Q-1 and the B input of A1-A to the 5 volt line through a 1k resistor (R-16) turning off Q-1 and insuring that A1-A is in the oscillator mode. To gate the oscillator on, a positive voltage is applied to J1, which via emitter - follower Q-3, causes A7-A to go low, A7-B to go high, and the oscillator to start. The oscillator will continue to run while the gate signal is present. When the gate signal is removed, the oscillator completes its final cycle.

One-Shot Position: The push button fires a J-K Flip Flop (A4-A) whose output turns off Q-3 through CR-5 and R-19. This manually simulates the input of a trigger pulse.

Output Circuit Operation

TTL Out: The TTL output is derived from four two-input NAND gates. A 4.7 Ω resistor limits the output drive to 40 TTL loads.

Var Out: Q-6 is the final driver for the VAR output. The collector of of Q-6 is tied to Vcc while the base is tied to the collector of Q-4 through a 47 Ω resistor. The collector of Q-4 is tied high through a 330 Ω resistor and is also shunted to ground by a 2.5k amplitude pot. Q-4 and CR-6 also provide active pulldown for the output when it is low.

The output is fed via a 47 Ω resistor, providing the correct output impedance and overload protection.

Sync Out: The inputs of A2-D are connected to a timing chain consisting of 3 TTL gates (A3-A, A3-B, A2-A) and R-31, C-22. The output of A3-D is normally high. When it goes low, there will be a brief interval before the signal reaches the output of A2-A in which neither input of A2-D will be high, and so a sync pulse will be generated. Depending on the position of the complement switch, the first transition of the output will either be simultaneous with the falling edge of the sync pulse or 15nsec after it.

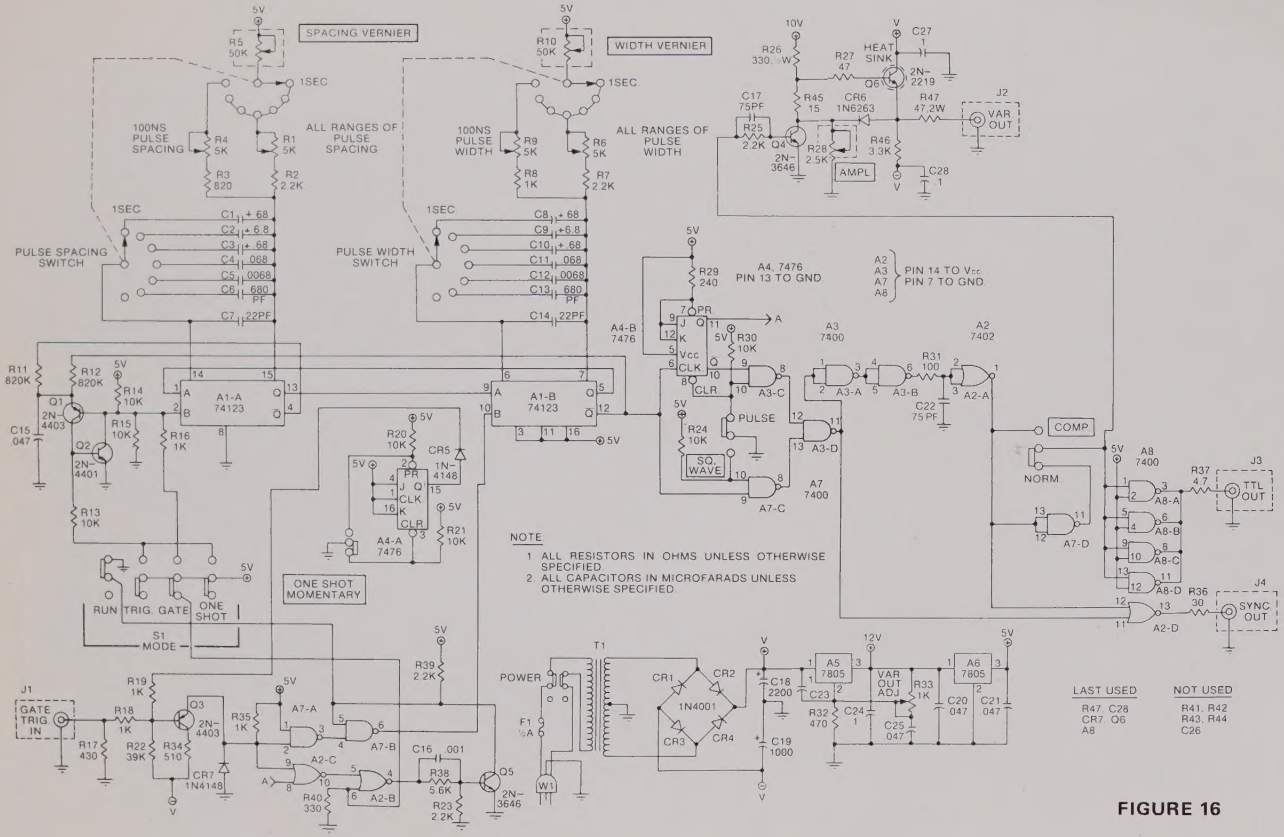

SPACING VERNIER
WIDTH VERNIER
1SEC
100NS PULSE SPACING
ALL RANGES OF PULSE SPACING
100NS PULSE WIDTH
ALL RANGES OF PULSE WIDTH
PULSE SPACING SWITCH
PULSE WIDTH SWITCH
A4, 7476 PIN 13 TO GND.
A2 A3 A7 A8 PIN 14 TO V++ PIN 7 TO GND.
A4-B 7476
A3 7400
A2 7402
A1-A 74123
A1-B 74123
A4-A 7476
A3-A
A3-B
A3-C
A3-D
A2-A
A7-C
A7-D
A7 7400
A8 7400
A8-A
A8-B
A8-C
A8-D
A2-D
PULSE
SQ. WAVE
COMP
NORM.
TTL OUT
SYNC OUT
HEAT SINK
AMPL
VAR OUT
ONE SHOT MOMENTARY
RUN TRIG. GATE ONE SHOT
S1 MODE
GATE TRIG. IN
POWER
NOTE
1 ALL RESISTORS IN OHMS UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
LAST USED
R47, C28
CR7 Q6
A8
NOT USED
R41, R42
R43, R44
C26

FIGURE 16

FACTORY SERVICE AND REPAIR

Continental Specialties Corporation will service and repair your 4001 free of charge for a period of ninety (90) days. (See Warranty). Please return your 4001, shipping charges prepaid, in its original box with a copy of sales slip or original invoice to:

CONTINENTAL SPECIALTIES CORPORATION
70 FULTON TERRACE
P.O. BOX 1942
NEW HAVEN, CONNECTICUT 06509

ATTN: SERVICE DEPARTMENT

Your 4001 will be repaired, retested and promptly returned to you. If your 4001 needs servicing and is out of warranty, follow the above instructions and enclose $20.00 for Factory Service.

WARRANTY

Continental Specialties Corporation warrants this device to be free from defective material or workmanship for a period of ninety (90) days from date of original purchase.

Continental Specialties Corporation under this warranty is limited to repairing the defective device when returned to the factory, shipping charges prepaid, within ninety (90) days from date of original purchase.

Units returned to Continental Specialties Corporation that have been subject to abuse, misuse, damage or accident; have been connected, installed or adjusted contrary to the instructions furnished by Continental Specialties Corporation or repaired by unauthorized persons will not be covered by this warranty.

Continental Specialties Corporation reserves the right to discontinue models; change specifications, price or design of this device at any time without notice and without incurring any obligation whatsoever.

The purchaser agrees to assume all liabilities for any damages and/or bodily injury which may result from the use or misuse of this device by the purchaser, his employees, or agents.

Continental Specialties Corporation shall not be liable in any way for consequential damages resulting from use of this device.

This warranty is in lieu of all other representations or warranties expressed or implied and no agent or representative of Continental Specialties Corporation is authorized to assume any other obligation in connection with the sale and purchase of this device.